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Helmut Kipphan (Ed.)

Handbook of Print Media

Technologies and Production Methods

Including 1275 figures, mostly in color
and 92 tables

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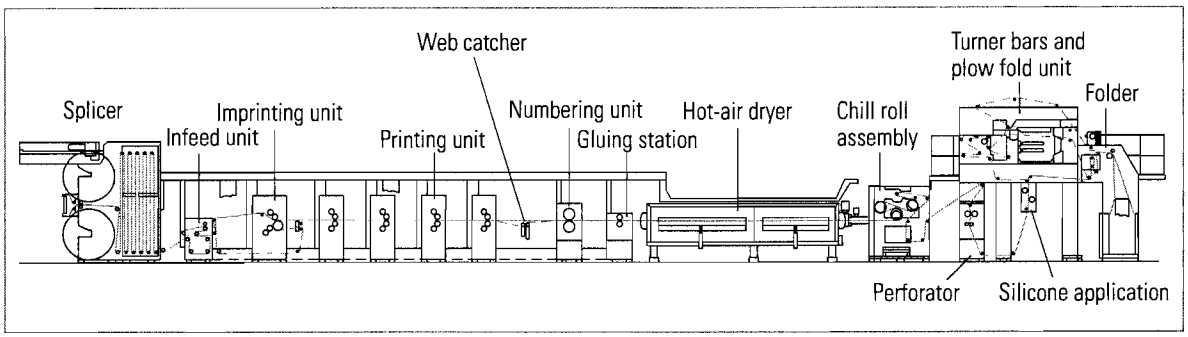


Fig. 1.6-9 Print line of a web-fed offset printing press with the individual units (IFRA/KBA)

which print the color separations onto the web. The web behavior during transport varies according to the cylinder surfaces, which requires a special dimensioning of the diameter of the steel cylinder and/or adaptations of the blanket cylinder packing.

Various *finishing equipment* is connected to the printing unit, such as the numbering unit, gluing station (for partial coating), dryers, chill roll assembly, slitters, turner bars, and perforators, as well as the formers and the folding unit, which all have some effect on web travel. To compensate for this the web travel is stabilized by driven draw rollers. In many applications (e.g., newspapers, magazines, catalogs) the folder with its cylinder section acts as a tensioning mechanism at the start of the web. Draw rollers acting on both sides are fitted at the entry of the folder, but it is the tucker blade cylinder of the jaw folder that exerts the actual tension. It is equipped with height-adjustable, curved plates or with circular shaped segments that correspond to the cylinder radius. The press does not need to be stopped for readjusting the tension, as it is equipped with a mechanism that allows adjustment during paper run. After the web or the ribbon bundle has been cross-cut in the folder, the sheets are transported and delivered by means of pins or grippers in the cylinder section of the folder. The web can also be cut into individual sheets after printing using "sheeters", and then stacked in a delivery like with sheet-fed presses.

Various Printing Unit Configurations on Web Presses

Web presses can be designed for all of the three main printing technologies: lithographic printing (offset printing), gravure printing, and letterpress/flexographic printing, as well as for non-impact printing technologies (sec. 1.3.3 and chap. 5). It is mainly the printing unit configurations of web presses for letterpress and offset printing that are explained in this section.

The *image carrier* (printing plate) in web-fed letterpress printing presses was, and to a certain extent still is, a round form (stereotype plate, electrotype plate, or wrap-around plate), which is mounted on a plate cylinder. This is brought into contact with an impression cylinder, a cylinder covered with a blanket. The paper web to be printed is routed through the two cylinders and the impression cylinder presses it against the plate cylinder to transfer the ink onto the web.

When lithographic printing (the di-litho method) was introduced into web printing, the only change to the above printing unit was that the letter press plate was replaced by a lithographic plate. At the beginning zinc plates were used. The dampening unit supplemented the inking unit, to enable the process of separating ink-accepting and non-ink-accepting, that is, ink-repellent, image areas on the flat form.

It was only with the invention of *offset printing* that a third cylinder was used as an intermediate image carrier. Accordingly the main elements of an offset printing unit therefore consisted of a plate cylinder, a blanket cylinder (a cylinder with a blanket covering), and an impression cylinder. The latter no longer needed to be coated, that is, covered with a blanket. Only with the invention of blanket-to-blanket printing could one of these additional cylinders be dispensed with again. Here two blanket cylinders are in contact with the web, which runs between the cylinders and is printed on the front and reverse side simultaneously (perfecting). This was a considerable improvement in rationalization.

Vertical Blanket-to-Blanket Unit

Nowadays virtually all printing units on commercial web offset presses (fig. 1.6-9) are designed in such a way that two blanket cylinders are arranged on top of one another with the web guided between them in a horizontal direction. The plate cylinders, the inking units, and the dampening units belonging to each printing unit are arranged at the top and bottom respectively. This printing unit configuration is referred to as a *vertical blanket-to-blanket unit* (fig. 1.6-10) with horizontal web travel. Four-color printing on both sides is produced by arranging four such blanket-to-blanket units in sequence (fig. 1.6-11). (Figure 1.6-10 shows a printing unit with a double-sized blanket cylinder and the possibility of printing two webs in printing units arranged in line.)

There are various options for installing and coupling presses for *multi-web production*. It is, for example, possible to install an identical but inverted production line on the other side of the folder. Another variant is to choose a two-level hot air dryer where both print lines are arranged behind each other and reroute the web via the second section (as illustrated in fig. 1.6-10). Double-deck configurations can also be found, as can parallel configurations with cross transfer of the second web to the common folder via turner bars. Of

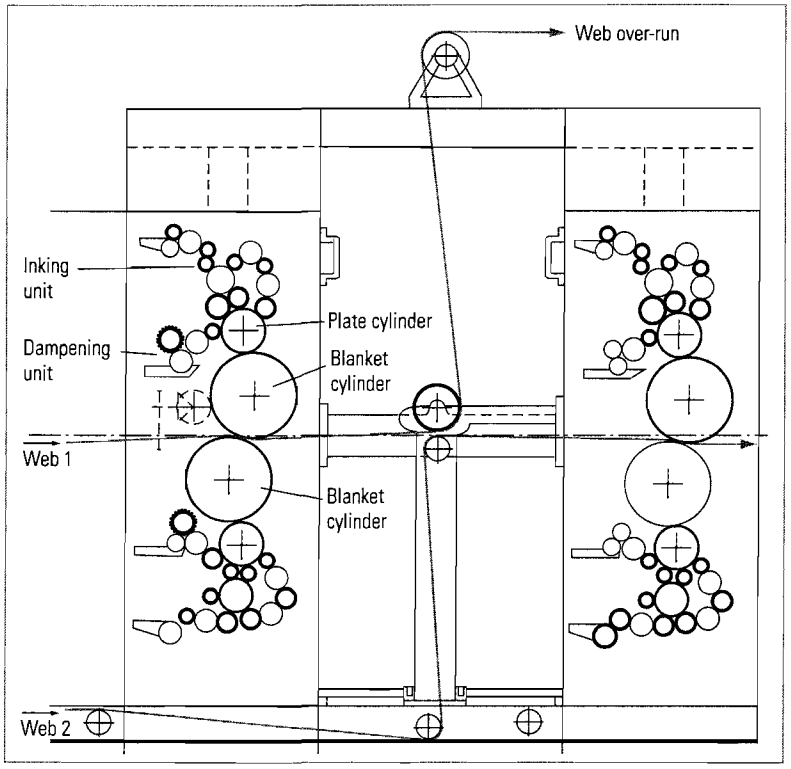


Fig. 1.6-10
Printing unit of a web offset press (vertical blanket-to-blanket unit) with horizontal web travel and possibility of a web over-run (IFRA)

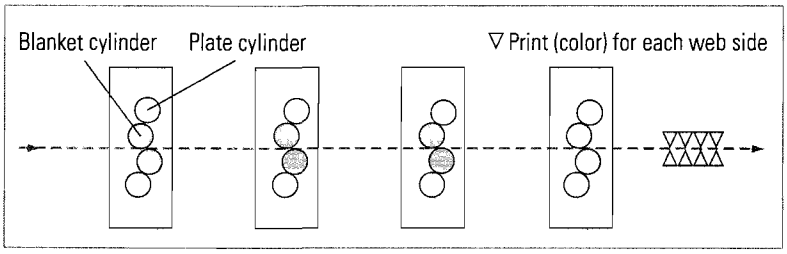


Fig. 1.6-11
Printing unit configuration for four-color printing on both sides of the web; vertical printing units for horizontal web travel

course it might be necessary to arrange more than four printing units in a row, for instance, when using spot colors or coatings. In addition the press can be equipped with "in-line finishing units", for example, for plow folding, punching, perforating, and applying adhesive (see sec. 2.1.6.2).

Horizontal Blanket-to-Blanket Unit (Arch-Type Printing Unit and Four-High Unit)

In newspaper printing multiple web operation is usually required. With the vertical blanket-to-blanket unit configuration described above this is very difficult to achieve. This led to the development of another basic design – the *arch-type printing unit*. Here, both blanket cylinders are brought into contact with each other in a horizontal direction and the web runs between them in a vertical direction. The plate cylinders, inking units, and dampening units are arranged to the sides of each blanket cylinder in a downward slanting direction. This results in an arch shape, giving the design its name.

Single-color printing on both sides in *multi-web operation* can be achieved by arranging several such arch-type printing units (printing towers) alongside each other with the reel stands in the basement of the building and the webs being fed through slits in the floor. For multicolor printing the arch-type printing units need to be stacked in a vertical direction. This means that for four-color prints on both sides of the web, four arch-type printing units are arranged on top of each other, producing the so-called *four-high unit* or *tower* (fig. 1.6-12).

To save on overall height, the vertical *U-type printing unit* was designed. This is arranged inverted to the arch-type printing unit, and placed on top of an arch-type unit to form an *H-type unit*. Two of these stacked on top of each other will form *a four-high unit*. The majority of applications now utilize this compact four-high design (fig. 1.6-13). The web has to travel the shortest distance between printing nips through this four-high configuration to produce a 4/4 print. Cylinders and web are easily accessible for the operator.

Initially, it was sufficient in newspaper printing to introduce individual spot colors and not to have them on all pages. So-called "*Y-shaped printing units*" (fig. 1.6-14) were quite adequate for this application, using blanket-to-blanket printing twice on one side to manage without a separate impression cylinder. There were also attempts to let two plate cylinders run in contact with one blanket cylinder. However, this only produced satisfac-

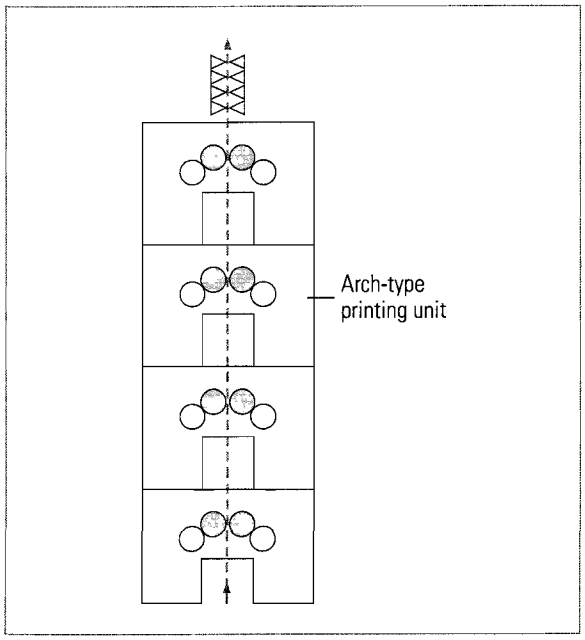


Fig. 1.6-12
Vertical web guidance in a "four-high unit" (four arch-type printing units stacked on top of one another for multicolor prints)

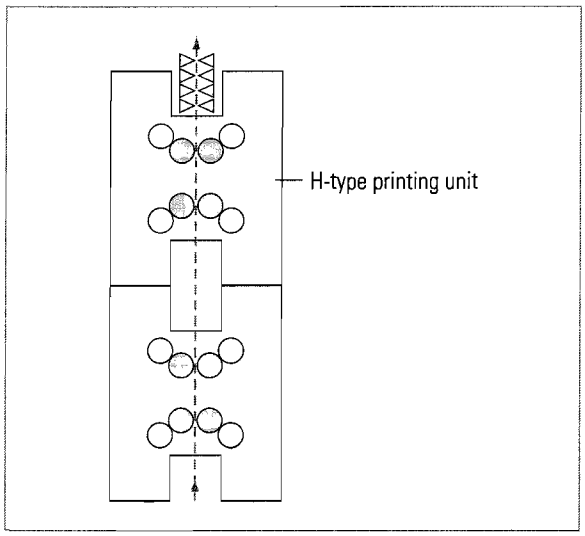


Fig. 1.6-13
Four-high unit for four-color printing (consisting of two H-type printing units)

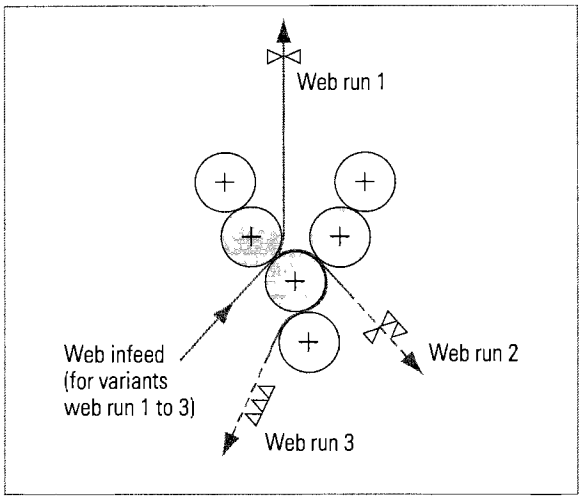


Fig. 1.6-14
Y-type printing unit for printing with up to three colors, three different web routes are possible

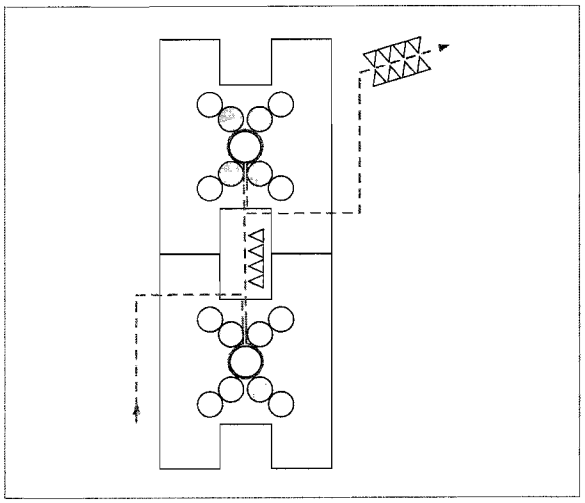


Fig. 1.6-15
Satellite printing units for four-color printing on both sides of the web; nine-cylinder satellite

tory results if the spot color was used completely separately and no overprinting of two colors was required.

Satellite Designs

The fear of not being able to print in accurate register in four-color printing where the web had to travel over a relatively long distance between the individual printing nips was the incentive for a design based on the *satellite construction*. Here, the four blanket cylinders are installed around a common impression cylinder (fig. 1.6-15). The advantage in terms of register accuracy results from the fact that the web is in contact with the common impression cylinder during the entire printing cycle. The four colors are printed very quickly one after the other, which gives the web little time to change its geometry due to the repeated application of dampening solution. In four-high units special measures have to be taken to compensate for changes in the web geometry (using so-called anti-fan-out rollers or buzzle wheels, etc., see sec. 2.1.3.2).

There are basically two different satellite configurations, the nine-cylinder satellite (fig. 1.6-15) and the ten-cylinder satellite (fig. 1.6-16). The latter is also called a *semi-satellite*. The most important designs are explained in greater detail in section 2.1.3.5.

Figure 1.6-17 shows a satellite (central cylinder) printing unit, as used in flexographic printing (for further information refer to sec. 2.3.3). Figure 1.6-18 shows

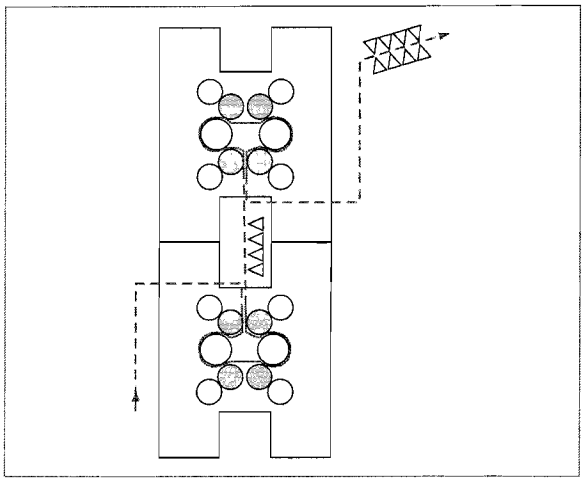


Fig. 1.6-16
Semi-satellite printing units (two ten-cylinder satellites, stacked) for four-color printing on both sides of the web

the printing units of a rotogravure press (for details see sec. 2.2).

Web Processing in the Folder

The web is cut and folded in various ways in the folder. This is done to create the end product (e.g., leaflet, newspaper) or at least an intermediate product partial

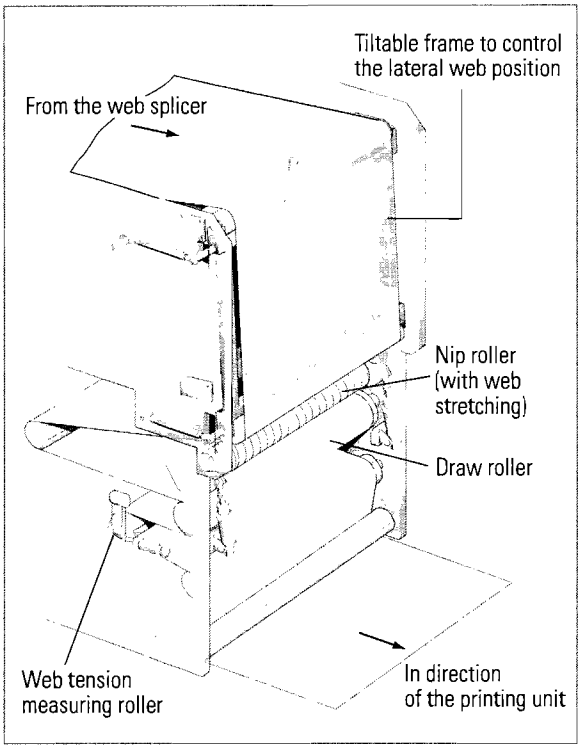


Fig. 2.1-98 Infeed unit (Heidelberg)

stand, the paper web is directed over a tiltable frame of parallel rollers located in the infeed unit (fig. 2.1-98), which provides for the lateral adjustment of the web during travel. The motorized positioning movement is effected by a controller that is linked to a web edge sensor. A wide range of different physical working principles can be applied for designing these sensors, extending from simple light barriers, pneumatic, ultrasonic and infrared sensors, through to cameras with CCD arrays. A distinction must also be made between control using two sensors to control the middle position of the web or to check to right edge of the web with the right-hand sensor and conversely the left edge with the left-hand sensor.

Register Control

Differentiation has to be made between the *circumferential* and *lateral register* in multicolor printing, the straight printing/perfecting register when printing on both sides, and the cut-to-print register in the folder. In addition, there is *diagonal register* or "cocking," which serves to correct an image copied obliquely by cylinder tilting (or plate shifting) and to compensate the "*fan-out" effect* of the web (enlargement of the web width) caused by the dampening during the printing process. With gravure presses, *print-to-print/color register control systems,* which are installed in-line and that adjust the register position during production automatically, are part of the standard equipment; however, they are now also used in web offset presses and newspaper web offset presses. Register control systems use optical sensors to detect register deviations on register marks printed on the web and initiate impression cylinder or web travel adjustments by means of servo-motors.

Register control is based on the following, proven principle: register marks are printed by each printing unit on the blank margin or on non-image areas on the prints. The deviation from the target position is measured by opto-electronic sensors and a correction impulse is calculated by the controller for the particular register servo-motor. Appropriate sensor or measuring systems can read very tiny register marks. Due to their size – sometimes only a fraction of a square millimeter – these register marks are hardly recognizable on the printed image, that is, they do not disturb the image and are easy to arrange. Newspaper printing presses using shaftless drive designs create optimal ways of register adjustment by means of electronic direct drives.

The latest development is aimed at recording print-to-print/color register together with other parameters in the print, such as image inspection and color measurement with special measuring devices, video cameras, and magnifying optics, which display the data on the screen for evaluation by the operator or make automatic adjustments.

Cut-to-print register control is necessary when running up the press, especially when using drum folders, in order to avoid a shifting of the fold in relation to the print. However, the shaftless drive has improved this situation to the extent that cut-to-print register adjustment can be occasionally left out.

"Fan-out" Control

Control and adjustment of the lateral register is particularly difficult in *newspaper printing*, for instance, two times four individual printing plates are mounted on one plate cylinder across the printing direction and each plate has already been produced with a lateral register error (see fig. 8.1-4). With the normal lateral register adjusting mechanism it is only possible to move the whole plate cylinder, and so only one of the eight plates would be properly adjusted. The "fan-out" effect causes anoth-

er problem, which could only be compensated for by the printing plates if they could be stretched laterally.

To compensate for the "fan-out" effect, the individual printing plates are arranged on the plate cylinder slightly off-center, that is, slightly less than the web is stretched by the fan-out effect. The fine adjustment is ensured by means of so-called buzzle wheels (fig. 2.1-99), which only allow the web width to be reduced. An optimal lateral register is thus achieved.

The "buzzle wheels" (fig. 2.1-99) in their simplest form are arranged on both sides of the web and are pressed into the paper web, thereby causing a waved deformation of the web. In more recent variants the buzzle wheels are driven at a lower speed, so that harmful effects reducing the product quality (e.g., ink set-off) and smearing are eliminated.

Slitters

With double-width newspaper web offset presses, the web must be cut into two halves in front of the former or formers to create a common newspaper product. For *tabloid products* printed on web offset presses, the web has to be cut to the former center (see fig. 2.1-113). In other words, the complete web is divided into a number of individual ribbons. However, any intervention on the web disturbs the web travel, as does slitting.

Slitting also involves the risk that the slitter might notch weak points into the paper, thus causing the web or the individual ribbons to tear. As is the case in metallurgy, a peak stress is exerted on the notches, which will cause the paper to tear even with the tiniest oblique line. Therefore, the web tension in the slitting knife area is sometimes reduced by installing controlled draw rollers that are set to low tension values in front of and after the slitters.

As far as slitter technology is concerned, there is a distinction to be made between shear cut-knives and blunt-cut knives (see fig. 7.2-9). To produce a shear cut, an upper and a lower knife operate like a pair of scissors, whereas the blunt cut is produced by a blunt knife pressing on a hardened smooth roller while the paper is running through between them. To produce a smoother cut with less serration, investigations are in progress to slit the web with high-pressure water jet or laser beam techniques. These methods are not yet in use.

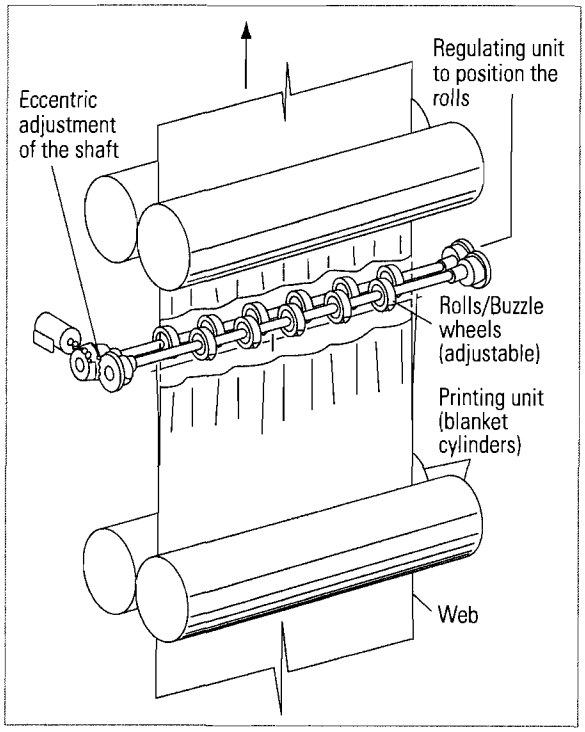


Fig. 2.1-99
"Buzzle wheels" for lateral "web buckling" to compensate for the "fan-out" effect (TKS)

Turner Bar

Another element that might influence the web tension and the position of the web is the turner bar (fig. 2.1-100). Turner bars are used to route one slit half of the web (a ribbon) from one side to the other, or to turn a ribbon to achieve a varying page arrangement within the product (fig. 2.1-116a). To compensate for the loss of tension, controlled draw rollers are incorporated into in the turner bar assemblies.

Blast air is circulated around the turner bars so that there is no friction and the ink does not offset on the turner bars and thus smudge the printed image. For the same reason, turner bars are chromium-plated. To circulate the blast air around the turner bars, the air is routed inside the hollow turner bar and then penetrates to the turner bar surface through very fine nozzles, that is, around those places where the paper wraps around the turner bar (fig. 2.1-100, see also fig. 2.2-20).

It has proved very useful to employ cantilever turner bars for fast paper infeed; this is on account of the greater accessibility.

Former

The effect of a former (fig. 2.1-88) is the same as using two turner bars arranged at an angle to each other, so

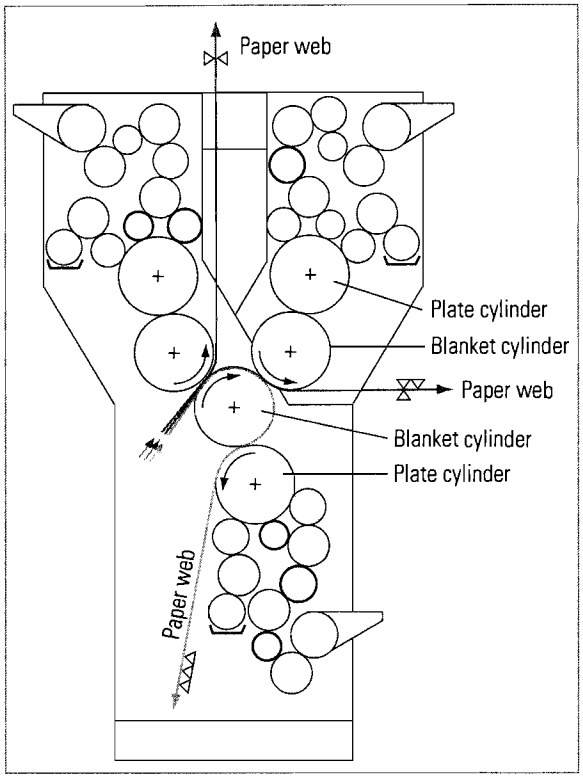


Fig. 2.1-118 Y-type printing unit (KBA)

"Color Deck"

The term color deck goes back to the time when newspaper printing units could only print monochrome, and "color decks" were installed above the actual printing units to imprint spot colors (see also figs. 2.1-200 and 2.1-201). Since a satellite printing unit (see fig. 2.1-102) is only suitable for four-color prints on one side, color decks were also used at a later date to print a web on both sides in one printing unit. The color decks were mostly constructed as a U-shape printing unit consisting of two printing couples, either with or without their own impression cylinders or else with a common impression cylinder. In this way it was possible to add 1/1 or 0/2 prints to the four-color prints or to webs with a spot color.

Four-High Unit

Four-high units were developed in the second half of the 1980s in response to an ever-rising number of different printing unit configurations available on the market, as a kind of "renaissance and back-to-nature movement." Four-high units are the simplest and the most compact method of producing a 4/4 job with one single printing unit. Here, too, two variations are available:

- four-high units consisting of two H-type printing units (fig. 2.1-120) arranged on top of each other (the H-type printing unit consists of an arch-type printing unit and a U-type printing unit) or
- four-high units consisting of four arch-type printing units arranged on top of each other. The latter has mainly been developed for printing units with keyless inking units to ensure equal geometrical ratios in all printing units.

To control lateral register deviations, the printing plates in four-high units must be laterally staggered to compensate for the expected "fan-out" effect (the web is laterally extended under the influence of dampening solution from the offset dampening unit). Minor corrections during printing can be carried out by anti-fan-out controllers, known as "buzzle wheels" (see sec. 2.1.3.2 and fig. 2.1-99).

Twin Satellite

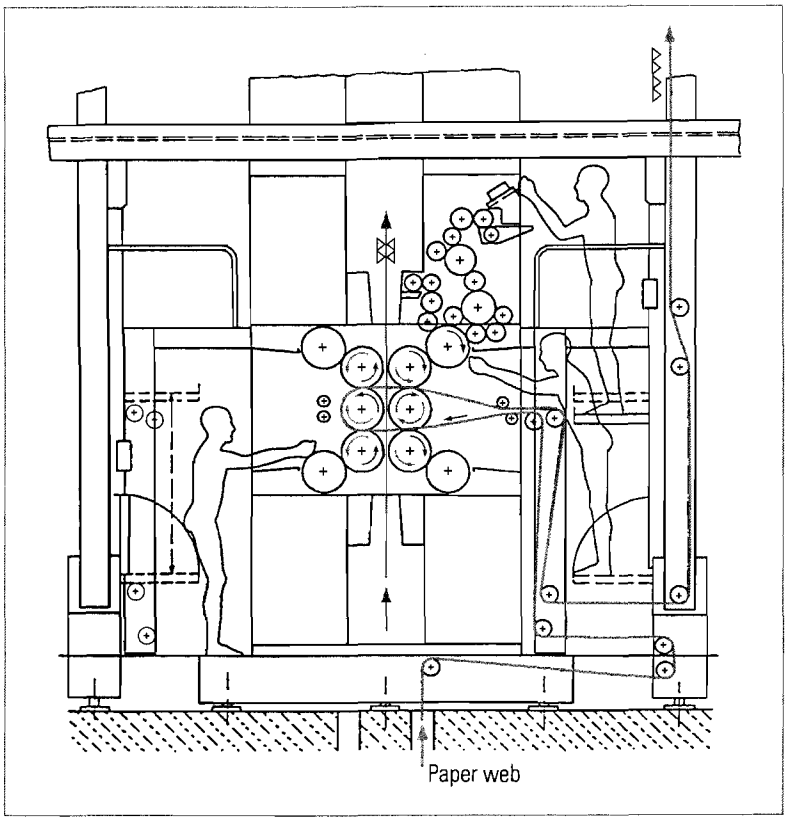
Twin satellites (fig. 2.1-121) have been developed to produce 4/4 prints with a single printing unit, but without any fan-out effect. Since there are so many different types of satellites, combi- and semi-satellites, twin-satellite designs have proliferated accordingly. However, modern systems are mainly offered without conversion, that is to say, we should no longer really talk of combi-satellites.

Twin-satellite designs are mainly used in Europe. In the United States, Asia, and Australia, four-high unit construction is still preferred.

Dampening Systems

With dampening systems in newspaper web offset presses, linting (i.e., fast soiling of the dampening solution) is an issue. As a result, there should be no reverse transfer of dampening solution to the water fountain with these systems. Hence, all dampening systems used in newspaper printing feature non-contact design. At the beginning, brush-type dampening systems were predominant. They were equipped either with an immersing brush or with a brush that was in contact with the water fountain roller (fig. 2.1-107). There is also a kind of "spiral roller" in the form of a turbo-dampening unit. However, jet-spray dampening systems are

Fig. 2.1-119
Semi-satellite (10-cylinder satellite) with vertical web travel and blanket-to-blanket printing (WIFAG)



used nowadays for the most part, due to their easy maintenance (see also fig. 2.1-108).

Keyless Inking Units

For thirty years, newspaper printing has been doing pioneering work in the field of keyless inking units. Solutions have been worked out that basically remove the residual ink film or the inhomogeneous ink relief from the ink form roller completely and apply a new homogeneous ink film. Until today three different designs have been used in practice (fig. 2.1-122):

- keyless inking units with Anilox (screen) rollers, that is, engraved, or structured metering rollers with doctor blade (figs. 2.1-122a and b);
- with pick-up roller and scraper blade (figs. 2.1-122d, e and f);
- with oscillating doctor blade (fig. 2.1-122c).

The second and the third designs enable a positive ink-feed, but in the case of the first design this needs to be achieved via the concentration or dilution of ink. It is said, however, that for normal newspaper printing this is hardly ever necessary.

Inking units with oscillating doctor blades represent the shortest design as far as the roller train is concerned; designs with pick-up roller and scraper blade are the longest, and inking units with an Anilox roller are in the middle. Advantages gained from keyless inking units suggest that keyless inking units will also be used in commercial web offset and sheet-fed offset presses in future. There are also developments aiming at waterless offset printing and the use of emulsion inks that already contain the emulsified dampening solution and thus do not require any additional dampening system.

Flying Plate Change and Changing the Web Width

In newspaper printing, several plates are usually mounted on one plate cylinder. This means that these plates can also be exchanged individually (see figs. 2.1-110 and 8.1-4).